

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

TITLE

Offset Angle Disc Clamp

FIELD OF THE INVENTION

The present invention relates generally to an apparatus and improvements in such apparatus for fastening of rotating circular plates, and, more particularly, to clamping improvements to prevent a disc from being warped due to the force associated with disc clamping.

BACKGROUND OF THE INVENTION

The present invention deals with disc drives. A typical disc drive includes one or more magnetic discs, which are mounted on a hub or spindle. When a plurality of discs are to be mounted on a hub, the discs are separated along the axial direction of the hub by spacers mounted between the discs. The disc, or plurality of discs, are mounted on a flange portion of the hub by a clamp apparatus. The clamping is such that the disc(s) rotate with the hub about the radial center axis of the hub. The primary method of disc clamps in prior art results in a vertical force point contact about a circumference point on the disc. This point contact can add additional warping to the disc itself.

1 A typical disc assembly will also include a
2 transducer(s) that is supported by an air bearing which
3 flies above the surface of each disc. The transducer and air
4 bearing are typically referred to as the read/write (R/W)
5 head. A drive controller controls the disc drive movement to
6 allow retrieval of information from the magnetic disc (or
7 writing of data to the disc). An electromechanical actuator
8 operates to move the data head radially over the disc
9 surface for track seek operations and holds the transducer
10 directly over a track for R/W operations.

11 Modern high performance disc drives employ head
12 positional servo loops. The function of the head positioning
13 servo system within the drive is to position the read/write
14 head over a data track with sufficient accuracy to enable
15 reading and writing of that track without error and to
16 position the write element with sufficient accuracy not to
17 encroach upon adjacent tracks to prevent data erosion from
18 those tracks during writing operations to the track being
19 followed. In order to satisfy these requirements, the
20 tracking system must be designed to reject disturbances.
21 These disturbances include noise from sources such as
22 spindle bearings, air turbulence, etc., and can be

1 classified into two general categories, those that generate
2 repeatable runout (RRO) and those that generate non-
3 repeatable runout (NRRO). The term "repeatable" is used to
4 describe periodicity on a revolution-by-revolution basis as
5 opposed to a track-by-track basis. The response of the head
6 positioning servo system to the RRO and NRRO sources is
7 track miss-registration (TMR).

8 Embedded servo systems derive head position information
9 from servo information interspersed within the data blocks
10 written on a surface of a rotating magnetic disc. One
11 advantage of employing embedded servo information is that
12 the same head and electronics are used to read both user
13 data and head position information. One of the major sources
14 of RRO is the servo write process that occurs during disc
15 drive manufacturing. The NRRO disturbance (bearing noise,
16 air turbulence, servo writer vibration, etc.,) that occurs
17 during servo write is essentially frozen into the written
18 position information and becomes the RRO for the particular
19 track.

20 It is known with a disc drive how to extract and
21 correct for RRO. Embedded servo fields are recorded on disc

1 surfaces and are used by a servo controller in accurately
2 aligning a read/write head over a desired track.

3 Disc assemblies typically have air filtration systems
4 to expunge any air borne particles at start up. Air passing
5 through a filter will carry any minute matter into the
6 filter to avoid disc contamination by such particles.

7 U.S. Pat. 4,885,652 dated Dec. 5, 1989 to Leonard et.
8 al titled 'Disk Cartridge' provides an air filter and ribs
9 incorporated into the inner surface of the cartridge, which
10 induce the air in the cartridge to flow toward the air
11 filters. When the disc is rotated at high speed within the
12 cartridge, airflow induced by disc rotation is directed
13 toward the air filters by the ribs adjacent to the outer
14 circumference of the disc it also is employed between the
15 disc and filter and induces internal airflow generated by
16 rotation of the disc toward the air filter(s). The present
17 invention will address ways of improving air flow in a hard
18 disc device.

19 Clamping of the disc on the hub is done prior to
20 derivation of the embedded servo information. Improper
21 clamping can add to creation of additional disc warping
22 along an annular track. Additional warping can cause the air
23 bearing to have an inconsistent flying height above the

1 surface of each disc effecting the head pick-up
2 amplification. This is commonly referred to as axial run
3 out. Point contact clamping apparatus can also affect non-
4 operational shock tolerance of the disc assembly. Clamping
5 that causes additional warping of the disc will also effect
6 RRO and track squeeze. As disc drives become smaller, there
7 is a tendency for the discs to warp into a potato chip type
8 shape due to the required clamping force of the disc clamp
9 to prevent any 'disc slippage'. Typical warping may be
10 somewhat sinusoidal extending outward from the point of each
11 fastener contact. Thus, a combination of annular point
12 contact and fastener contact will distort the flatness of a
13 disc in a non-uniform manner. All manufactured disc drives
14 have drop specifications, which are a force expressed in
15 g's. All of these factors necessitate an improvement in disc
16 clamping.

17 The present invention addresses these and other
18 problems, and offers other advantages over the prior art by
19 improvements in a disc clamp apparatus.

20

21

22

23

1 **SUMMARY OF THE INVENTION**

2 The main aspect of the present invention is an
3 improvement in the distribution of clamp-to-disc vertical
4 holding force over a set area.

5 Another aspect of the present invention is to reduce
6 disc slip.

7 Another aspect of the present invention is to decrease
8 warping of the disc caused by clamping.

9 Another aspect of the present invention is to enhance
10 R/W head flying height consistency, thus improving data
11 transfer reliability and axial run out.

12 Another aspect of the present invention is to improve
13 the non-operational shock tolerance of the disc assembly.

14 Yet another aspect of the present invention is to
15 improve the RRO of the disc assembly.

16 Still another aspect of the present invention is to
17 reduce any track squeeze due to warping of the disc.

18 Another aspect of the present invention is to utilize
19 elevated ribs (or grooves) on the base housing to direct air
20 flow towards a filter.

21 The present invention consists of an offset angle disc
22 clamp apparatus that employs an outer annular, flanged
23 contact surface with an angular offset on its clamp-to-disc

1 contact surface. The angular contact surface extends
2 radially inward at the clamp-to-disc contact surface at an
3 angle of about 3° such that the outmost radial contact
4 surface is in initial contact with the disc prior to
5 applying torque to the clamp-to-hub fasteners. The offset
6 angle clamp provides a disc-to-clamp interface angled
7 (tilted) edge such that application of torque on the clamp-
8 to-hub fasteners will result in the initial angular offset
9 surface moving into a parallel contact surface position with
10 the disc as torque is applied, thus resulting in an even
11 distribution of the clamp-to-disc force.

12 The embodiment of the present invention provides an
13 offset angular disc clamp comprising:

14 an annular clamp characterized by further
15 comprising an outermost annular surface with an angular
16 offset of about 3° extending inward towards the clamp
17 radial center;

18 means for fastening said clamp to a disc assembly
19 hub with a clamp to disc fastener(s);

20 an inner annular opening positioned axially about
21 its center such to allow alignment with the hub; and

22 means for applying a predetermined vertical force
23 on the clamping fasteners.

1 The present invention also employs raised ribs to
2 enhance airflow induced by disc rotation, directing airflow
3 toward the air filters by the ribs, which is located beyond
4 the outer circumference of the disc. The result of such ribs
5 providing a faster clean out time for any latent particles
6 is allowing for a faster start-up time.

7 Other aspects of this invention will appear from the
8 following description and appended claims, reference being
9 made to the accompanying drawings forming a part of this
10 specification wherein like reference characters designate
11 corresponding parts in the several views.

12 **BRIEF DESCRIPTION OF THE DRAWINGS**

13 Fig. 1 is an illustrative cross sectional side view
14 drawing of a clamp to disc contact area (prior art).

15 Fig. 2 is an illustrative cross sectional side view
16 drawing of a spring clamp to disc contact area (prior art).

17 Fig. 3a is an illustrative cross sectional drawing of
18 the angular offset of the offset disc clamp to disc contact
19 area of the present invention.

20 Fig. 3b is an illustrative cross sectional drawing
21 depicting the angular offset of the clamp to disc area of
22 the present invention, also showing a disc to hub fastener.

1 Fig. 4a is a top view showing an annular disc track
2 flatness curve comparing prior art to the present invention.

3 Fig. 4b is a side cross sectional view of a disc with
4 clamp prior to any clamping force being applied.

5 Fig. 4c is a side cross sectional view a disc with the
6 offset angle disc clamp of the present invention after a
7 force is applied.

8 Fig. 4d is a side cross sectional view of a disc with a
9 prior art clamping mechanism.

10 Fig. 5a is a bottom view of the offset angle disc clamp
11 of the present invention.

12 Fig. 5b is a side cross sectional view of the offset
13 angle disc clamp of the present invention.

14 Fig. 5c is a cross sectional blow up of cutout **G** of
15 Fig. 5b.

16 Fig. 6 is a top perspective view of the offset angle
17 disc clamp of the present invention.

18 Fig. 7 is a perspective drawing of a disc sub-assembly.

19 Fig. 8 is a perspective drawing of a disc sub-assembly
20 without the disc(s) in place showing raised ribs to move air
21 flow towards a filter.

22 Before explaining the disclosed embodiment of the
23 present invention in detail, it is to be understood that the

1 invention is not limited in its application to the details
2 of the particular arrangement shown, since the invention is
3 capable of other embodiments. Also, the terminology used
4 herein is for the purpose of description and not of
5 limitation.

6

7 **DETAILED DESCRIPTION OF INVENTION**

8 The present invention provides an offset angle disc
9 clamp, which is an improvement in the distribution of clamp-
10 to-disc vertical holding force. An even distribution of the
11 vertical holding force over a set area will reduce any disc
12 slip. This even distribution allows improved ability of the
13 disc assembly to withstand drop force. An even distribution
14 of vertical holding force will also decrease warping of the
15 disc caused by the clamping mechanism itself by avoiding an
16 annular point-contact force. Reduced warping will enhance
17 R/W head flying height consistency (or axial run out), thus
18 improving data transfer reliability. A reduction in head
19 movement while reading a track (axial run out) minimizes
20 head movement in a vertical direction with respect to the
21 disc surface. Reduction in axial run out will improve the
22 signal to noise ratio of the head pickup mechanism and
23 provide for consistent signal amplitude.

1 The even distribution of vertical holding force is
2 accomplished by applying an offset angle to the annular
3 peripheral contact surface of the clamp-to-disc surface.
4 With the offset angle, prior to applying torque to the
5 fasteners, only a point contact will be made at the outer
6 peripheral surface of the offset angle disc clamp to disc
7 surface. As the fasteners, which attach to the offset angle
8 disc clamp to the hub, have torque applied, the outer
9 peripheral surface will gradually move from a peripheral
10 point contact to a distributed surface area contact. Initial
11 measurements via use of surface flatness measurement
12 equipment such as supplied by Zygo™ Corp. were performed to
13 optimize both the offset angle and torque requirements.
14 These measurements were done to compare disc surface
15 flatness of various prior art clamping mechanisms including
16 the clamping with zero offset angle versus use of an offset
17 angle on the clamp peripheral annular surface. Initial
18 measurement results showed that using an approximate 3°
19 offset angle at the peripheral annular surface of the disc
20 along with approximately 4 inch-pounds at each of six
21 fasteners resulted in greater than a 2.5x improvement in
22 surface flatness distortion over prior art clamping
23 mechanisms. For example, typical distortion without an

1 offset angle showed disc surface flatness in the range of
2 about 600 to 650 micro-inches due to clamping, whereas
3 utilization of the offset angle disc clamp of the present
4 invention resulted in surface flatness in a range of about
5 200-250 micro-inches. One important factor is that the
6 present invention not only improves surface flatness but
7 also made it more uniform. That is, single annular tracks
8 were basically flat. The disc flatness uniformly moved from
9 inner to outer tracks, as does a surface of a nearly perfect
10 conical shape. Prior art clamping resulted in flatness
11 distortion within each single track(s). This results in
12 significant improvements in axial distortion. Drop force
13 tolerances also improved from about 250g's to about 300g's
14 of force. In the preferred embodiment of the present
15 invention an outer diameter of the hub is in the range of
16 about 1.250" with the peripheral annular surface extending
17 in towards the hub central axis to an inner diameter of
18 about 1.100". Thus the annular contact surface area of the
19 offset angle clamp-to-disc is about 0.150" wide for a
20 contact area of about 0.277 in². Thus, the annular contact
21 surface is a peripheral contact surface having a length
22 along a radius from the center of the hub. That length (or
23 straight line segment) in the preferred embodiment is about

1 0.150". The segment starts from an inner to an outer contact
2 edge along the radius of the hub. Carbon paper was used at
3 the contact area interface to measure and insure even force
4 distribution in determining the optimized torque with the 3°
5 offset angle. Although the preferred embodiment of the
6 present invention provides for six clamp to disc fastener
7 points, other designs can easily be incorporated. Also, for
8 example, three of the six fastener points may be
9 incorporated or an alternate embodiment can employ a disc
10 clamp with a plurality of fasteners other than six. It
11 should also be noted that although an offset angle of about
12 3° is utilized as the preferred embodiment of the present
13 invention, other offset angles could be used along with
14 other torque and/or fastener requirements.

15 As aforementioned, it should be noted that prior art
16 disc clamps resulted in inconsistent flatness measurements
17 from an inner track to an outer track and that flatness
18 along a track was not constant. Flatness along an annular
19 track using prior art clamping methods was somewhat
20 sinusoidal or random contributing to axial run out.
21 Measurements taken with the offset angle clamp of the
22 present invention shows that it maintains a uniform flatness
23 along a track, thus minimizing axial run out. Not only does

1 the present invention offset angle clamp result in
2 consistent flatness along a track but also it minimizes
3 flatness changes as the head moves from an inner to outer
4 track on a disc. The resulting profile is a cone shape from
5 the inner to the outer track. Flatness along a radial arm
6 extending from inner to outer tracks was measured to be a
7 uniform change with a maximum change of about 150 micro-
8 inches.

9 In reducing total disc flatness (or warp) due to disc
10 clamping, the RRO and NRRO of the disc assembly is also
11 improved along with reduction of track squeeze. Track
12 squeeze is defined as the track width becoming smaller in
13 relation to the pickup head due to its warp.

14 The present invention also employs one or more raised
15 rib surface(s) on the base plate (or housing) assembly. The
16 raised rib(s) form a groove(s) and function to move airflow
17 towards an air filter mounted on the base plate outward of
18 the disc itself. The directed airflow can reduce start-up
19 time of the disc by providing a quicker clean up time to
20 trap any random particles within the base plate assembly.
21 The rib(s) (or raised grooves) direct air flow to the filter
22 by providing a raised groove for about 180° in a radial
23 direction and having the groove curved in an outward radial

1 direction, stopping prior to the filter location. Thus air
2 flow is moved in an outward direction to the filter as it
3 moves in an annular-like path around and within the base
4 assembly.

5 Referring now to the drawings, Fig. 1 is an
6 illustrative cross sectional side view of a clamp to disc
7 contact area (prior art). Disc **10** has a flat surface and
8 clamp **11** is in contact with disc at clamp outer surface **S_A**
9 prior to any fastener torque and resulting clamp force **D_A**
10 applied by a fastener (not shown). Application of fastener
11 torque and clamp force **D_A** to an inner fastener area of the
12 clamp will result an outer area clamp force **F_A** applied as
13 the clamp is distorted in a downward direction **C_B** on its
14 inner area. Outer clamp surface **S_A** will be caused to lift in
15 direction **C_A** and the resulting effect will be a point
16 contact **P_A** at the clamp to disc interface. Point contact **P_A**
17 will cause disc **10** to warp in an upward direction **B_A**. It
18 should also be noted that the disc would not only warp in a
19 radial direction but also in an annular direction (ref. Fig.
20 4). Each fastener contact point will cause a 'wave like'
21 warping of disc **10**, resulting in an uneven flatness along a
22 single annular track.

1 Fig. 2 is an illustrative cross sectional side view of
2 a spring clamp to disc contact area (prior art). Disc **10** has
3 a flat surface and clamp **21** is in contact with disc at
4 spring clamp surface **P_A**. Fastener torque and resulting clamp
5 force **D_B** is then applied by a fastener (not shown) to clamp
6 the disc to a hub. Application of clamp force **D_B** will result
7 in downward spring clamp force **F_B** as the inner area of the
8 spring clamp is distorted in downward direction **C_B**. Downward
9 spring clamp force **F_B** and inner fastener (not shown) will
10 cause the outer area of disc **10** to lift in direction **B_A** and
11 will cause disc **10** to warp in an upward direction **B_A**. Again,
12 as discussed in Fig. 1, each fastener contact point will
13 cause a 'wave like' warping of disc **10** (ref. Fig. 4),
14 resulting in an uneven flatness along a single annular
15 track.

16 Fig. 3a is an illustrative cross sectional drawing of
17 the angular offset of the angular offset disc clamp **31** to
18 disc **10** area of the present invention. Initially the outer
19 surface of disc clamp **31** is in point contact **32** with disc **10**
20 and an angular offset **A** of about 3° allows angular offset
21 disc clamp **31** to be in contact at only one point contact **32**
22 prior to applying torque to any fastener. As fastener

1 clamping torque force D_c is applied, inner downward clamp
2 motion C_b occurs on clamp **31**. As this motion occurs, angular
3 offset A decreases from 3° to 0° offset (dashed line) and
4 point contact **32** changes to form a uniform contact area with
5 an evenly distributed clamping force F_c applied to the
6 clamp-to-disc surface. The clamping force F_c is distributed
7 along the entire contact area. The contact area has a radial
8 length (or segment) D along a radius from the center of the
9 hub that starts from the inner contact edge of clamp **31** to
10 the outer edge of clamp **31**, the outer edge having initial
11 point contact **32**. This will result in a uniform flatness
12 along the outer annular disc clamping area. It will also
13 result in an even distribution of flatness from inner to
14 outer disc tracks. The resulting disc shape, using the
15 offset angle clamp, will be conical from innermost to
16 outermost disc track. Because each track is flat within
17 itself, axial run out is virtually eliminated in reading of
18 a track.

19 Fig. 3b is an illustrative cross sectional drawing
20 depicting the angular offset of the clamp **31** to disc **10** area
21 of the present invention, also showing a disc to hub
22 fastener **35**. Fig. 3b is an extended cross sectional view of

1 Fig. 3a. As previously stated, initially the outer surface
2 of disc clamp **31** is in point contact **32** with disc **10** and an
3 angular offset **A** (ref. Fig. 3a) of about 3° allows angular
4 offset disc clamp **31** to be in contact at only one point
5 contact **32** prior to applying torque force **D_c** to fastener **35**.
6 As fastener clamping torque force **D_c** is applied via
7 tightening fastener **35**, inner downward clamp motion **C_B**
8 occurs on disc clamp **31**. As this motion occurs, the angular
9 offset decreases (ref. Fig. 3a) from 3° to 0° offset and
10 point contact **32** reforms to a uniform contact area with an
11 evenly distributed clamping force **F_c** applied to the clamp-
12 to-disc surface. This will result in disc clamp **31** having a
13 uniform flatness along the single clamp to disc contact
14 area. It will also result in an even distribution of
15 flatness from inner to outer disc tracks with an evenly
16 distributed clamping force **F_c**. The resulting disc shape,
17 using the offset angle clamp, will be conical from innermost
18 to outermost track. Because each track is flat within
19 itself, axial run out is virtually eliminated in reading of
20 a track.

21 Fig. 4a is a top view showing an annular disc track
22 flatness curve comparing prior art to the present invention.

1 Disc clamp **31** having a uniform distribution of clamping
2 force (ref. **F_c**, Fig. 3a) results in annular storage track **41**
3 having a uniform flatness curve about disc **10** as represented
4 by the circular shape. The use of prior art clamping (ref.
5 Figs. 1,2) would result in non-uniform flatness track **42**
6 about disc **10**. Torque applied to fastener(s) **35** aggravates
7 the non-uniform flatness around a track and from an inner to
8 outer track. Flatness would also be non-uniform from one
9 track to another. It should be noted that although only one
10 storage track is shown, disc clamp **31** of the present
11 invention results in each track being flat about the center
12 of disc **10** such that disc **10** will be conical from its
13 innermost to outermost disc track.

14 Fig. 4b is a side cross sectional view of disc **10** with
15 clamp **31** prior to any clamping force being applied. In this
16 situation disc **10** has no stress applied to its surface and
17 remains perfectly horizontal in its shape.

18 Fig. 4c is a side cross sectional view disc **10** with
19 offset angle disc clamp **31** of the present invention after a
20 force is applied. In this case the disc has a small amount
21 of distortion but the distortion is in a conical shape about
22 the clamp and the flatness across the surface extends to an

1 offset flatness **h** which has been measured to be in the range
2 of about 200-250 micro-inches. Thus each single annular
3 tracks basically flat (ref. Fig. 4a) and disc flatness
4 uniformly moves from the inner to outer tracks, as does a
5 surface of a nearly perfect conical shape.

6 Fig. 4d is a side cross sectional view of disc **40** with
7 a prior art clamping mechanism **11**. The disc surface offset
8 flatness **p** has been measured to be in the range of about 600
9 to 650 micro-inches due to clamping versus the present
10 invention (ref. Fig. 4c) resulted in surface offset flatness
11 in a range of about 200-250 micro-inches. It should also be
12 noticed that the disc shape is somewhat 'taco' shaped which
13 results in a non-uniform flatness track (ref. Fig. 4a)
14 within each single disc track.

15 Fig. 5a is a bottom view of the offset angle disc clamp
16 **31** of the present invention. An inner clamp cutout starts at
17 surface radial point **51**, which allows offset angle disc
18 clamp **31** to centrally mount on a hub motor (not shown) with
19 the hub motor mounted through inner clamp cutout hole **52**.
20 Offset angle disc clamp to motor hub fasteners (not shown)
21 mount through fastener holes **33** and function to secure
22 offset angle disc clamp **31** to the motor hub. Clamp-to-disc
23 contact surface **55** is on the bottom surface and forms the

1 uniform contact area as discussed in Figs. 3a, 3b. Oval
2 radial ridge surface **57** is on the top surface and is used
3 for manufacturing purposes only. Counter bore offset radial
4 ridge point **58** is the start of a counter bore at the top
5 surface which extends from offset radial ridge point **58** to
6 cutout radial point **51** forming a counter bore in the center
7 section of the clamp which also is a manufacturing function.

8 Fig. 5b is a side cross sectional view of the offset
9 angle disc clamp **31** of the present invention. Clamp-to-disc
10 offset contact surface **55** forms the uniform contact area
11 with a disc surface. Cutout fastener holes **33** are for disc
12 to hub motor clamping fasteners. Inner offset angle disc
13 clamp hole **52** allows the motor hub to accept proper clamp
14 centering. Clamp-to-disc offset contact surface **55** has the
15 offset angle of about 3° (see cutout **G**, Fig. 5c) at its
16 outer boundary. Top surface **59** is essentially flat.

17 Fig. 5c is a cross sectional blow up of cutout **G** of
18 Fig. 5b. Angular offset angle **A** extends through clamp-to-
19 disc offset contact surface **55** and has an angle of about 3°
20 extending inward from outer clamp surface **61**. The offset
21 angle **A** decreases from 3° to 0° offset moving outer annular
22 offset contact surface **55** to form a distributed contact with

1 disc surface **56** as clamping force is applied to the
2 fasteners (not shown). This will result in uniform disc
3 flatness along the annular offset contact surface **55**. Offset
4 contact surface **55** extends for a segment length **D** and
5 extends from an inner to an outer contact edge along a
6 radial segment of the hub. In the preferred embodiment of
7 the present invention, segment length **D** is about 0.150".
8 Also shown in Fig. 5c is radial ridge **57** on the top clamp
9 surface, which is used for manufacturing purposes. Edge
10 surface **60** and top surface **59** are both essentially flat
11 horizontal surfaces.

12 Fig. 6 is a top perspective view of the offset angle
13 disc clamp **31** of the present invention. Outer clamp surface
14 **61** is essentially vertical and contacts with the outer
15 offset contact surface **55** (ref. Figs. 5a, 5b, 5c). Edge
16 surface **60** is essentially a horizontal flat surface. Radial
17 ridge **57** is an oval shaped ridge between flat edge surface
18 **60** and top surface **59**. The oval shaped ridge is non-
19 functional and is for manufacturing purposes. The area
20 between edge of top surface **58** and inner diameter radial
21 point **51** is basically a flat counter bore area. Fastener
22 holes **33** are also shown.

1 Fig. 7 is a perspective drawing of disc sub-assembly
2 **70**. Base plate **71** is typically a cast aluminum housing which
3 holds all electronics, discs, motors, R/W heads, air
4 filters, actuator assemblies, etc. Offset angle clamp **31** is
5 shown holding disc **10** in place within base plate **71**. Offset
6 angle clamp **31** is shown with a total of six fastening holes
7 **33**. It should be noted that although six fastening holes are
8 depicted, the present invention could also employ other
9 embodiments with another quantity of fastening holes, or,
10 other embodiments which would used only a partial number of
11 fasteners. For example, three fasteners could be employed in
12 the six holes shown.

13 Fig. 8 is a perspective drawing of a partial disc
14 sub-assembly **80** without the disc(s) in place showing raised
15 ribs **82** to move airflow in direction **A_F** towards air filter
16 **81**. Airflow is created by rotation of the disc (not shown).
17 Raised ribs **82** are set into base assembly **71**. Although two
18 raised ribs are shown on the base plate (or housing)
19 assembly other embodiments could employ one or more to
20 direct air. Raised ribs **82** form grooves and function to move
21 airflow in direction **A_F** towards air filter **81** mounted on
22 base plate **71** outward of the disc area. Groves **82** providing

1 directed airflow **A_F** reduce start-up time of the disc drive
2 by providing a quicker clean up time to trap any random
3 particles within base plate assembly **80**. Raised ribs **82**
4 extend for about 180° in a radial direction towards air
5 filter **81** with a form curved in an outward radial direction,
6 stopping prior to the filter location. Thus air flow is
7 moved from inward to an outward direction to the filter as
8 it moves in an annular-like path around and within the base
9 assembly. Also shown are R/W head **83** and motor hub **34** to
10 which clamp **31** attaches disc(s), which are not shown.

11 Although the present invention has been described with
12 reference to preferred embodiments, numerous modifications
13 and variations can be made and still the result will come
14 within the scope of the invention. No limitation with
15 respect to the specific embodiments disclosed herein is
16 intended or should be inferred.

17

18